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(p. 15, 16). Yet, even Maxwell speaks of 'heat rays,' almost as if they objectively possessed heat, and, of course, with the implication that 'rays of light' are not 'heat rays.' Can it be urged too strongly that the rays differ objectively only in wave-length and amplitude, and that their relations to heat and light are entirely and absolutely subjective? Yet loose phrasing is continually met with. Langley writes of 'luminous heat' and of 'the radically different character of the heat in these two maxima' (A. J. S., ut supra, 434, 435). Hallock writes: "Then it was that heat was recognized as another manifestation of those periodic disturbances, or waves, in that elastic medium which was then known as the luminiferous ether, and which is now universally known as 'the ether' (SCIENCE, ut supra, 174). Perhaps this refers to the mis-recognition of the early part of this century; perhaps professional physicists get along comfortably enough with 'dark heat rays' and the rest; but to those who have to use physical results in other lines of study, this indefinite phraseology is very troublesome.

W. M. DAVIS.

HARVARD UNIVERSITY, Sept. 30, 1895.

SHELLS AS IMPLEMENTS.

PLEASE call the attention of those who own or have charge of archæological cabinets to an illustration in von den Steinen's 'Unter den Naturvölkern Zentral Brasiliens,' 1894, p. 207, fig. 27. A fresh water mussel shell has a hole through it just as you see in specimens on plate xxvi. of Holmes' paper 'Art in Shell.' But von den Steinen says that these shells are used as scrapers; the edge on large objects and the hole through the shell is also used by the tribes living on the upper Shingu for smoothing or scraping wood. His next remark about pushing the hole in with an Akuri nut I do not comprehend.

O. T. MASON.

THE INVERTED IMAGE ON THE RETINA.

IN the last number of this journal (p. 438) Professor Brooks writes: "We all believe many things which are inconceivable, such as the truth that the image in our eyes is upside down." But why is this inconceivable? To those having knowledge of elementary physics it is inconceivable that the image should not be inverted. Perhaps Professor Brooks means that it is incomprehensible that we should see things right side up when the image is upside down. This is sometimes urged, but would seem to be sufficiently answered by a remark once made by Lotze in the presence of the writer: "If any one is troubled by the fact that the image is inverted, let him suppose that the soul stands on its head." It is, indeed, quite as reasonable to suppose that the mind stands on its head as to suppose that it stands on its feet and looks at the image on the retina —which would seem to be the assumption of those who are troubled by the phenomenon.

A similar paradox is the fact that with two images on the retinas we see things singly. This may also be treated without undue seriousness by the question: "If we hear a baby crying with two ears, why do we not think it is twins?

J. McK. C.

SCIENTIFIC LITERATURE.

Mental and Physical Fatigue by M. MOSSO. Translation by P. Langlois. (Bibliothèque de philosophie contemporaine.) Paris, Félix Alcan. 1894.

The Difference Between the Muscles in Their Normal and Their Abnormal, or Fatigued Condition by M. WEDENSKY. Archives de physiologie; Comptes rendus de l'Académie des Sciences.

It is but recently that problems of this nature have been treated by physiologists.

Kronecker, in his experiments on the detached muscles of the frog, succeeded in obtaining 1,000, even 1,500 contractions, the intensity of which decreased regularly in proportion to the increase of fatigue; thus, for contractions at regular intervals, produced by currents of equal intensity, the curve of fatigue is a straight line. Kronecker also observed the great individual differences existing in animals in their power of resistance to fatigue.

M. Mosso, the author of the present work (unfortunately abridged in the French translation), is an Italian physiologist who has undertaken with an instrument of his own invention,

which he calls an 'ergograph,' to measure the normal variations of muscular force in man. The work contains illustrations of the apparatus in question, as well as the various curves obtained by the experiments. The instrument consists: (1) of a small cushioned platform upon which the forearm rests, fastened down at the wrist in such a manner as to give free play to the fingers, the hand remaining immobile meanwhile; (2) a pulley, consisting of a wheel and cord, one end of which is attached to a weight and the other end to the finger to be experimented upon—usually the middle finger. To this cord, moving in a groove, is fixed a sliding pen, the point of which rests upon the registering cylinder above. At intervals of two seconds, marked by the metronome, the subject is expected to concentrate all his force on the muscles of the middle finger for the purpose of lifting the weight at the other end of the cord. The weight thus lifted was usually 3 kg. The line passing through the maxima of the contractions formed the curve of fatigue.

Experiments of this character are open to theoretical objection. It is evident, from the curves obtained by the registering cylinder, that the digital contractions are in no case instantaneous, and that each portion, or part, of a given contraction differs from the preceding or succeeding one. However, the conditions of M. Mosso's experiments were practically such that the variations of time between the different fractions of contraction were but slight. For all practical purposes, then, the curve thus obtained may be considered a curve of instantaneous effort in equal intervals of time.

Similar experiments, made upon himself by M. Aducco, a fellow-worker of the author, show two curves—one obtained in winter, the other in summer. They are not alike. These curves vary not only for different subjects, but also for the same subject under various conditions dependent upon the state of health or preceding muscular effort.

There is also given a curve of fatigue produced by an interrupted current applied in the same manner to the median nerve. The intensity was not at its maximum, but the author affirms that an increase of intensity augments but feebly the amplitude of the contractions. The curve thus obtained is essentially the same as that obtained by muscular contractions under the influence of the will, from which he concludes that physical fatigue is a phenomenon depending on the muscles rather than on the excitability of the nervous centers. Nevertheless, if we consider an effort of the muscles excited by the will and an effort of the muscles excited by electricity simultaneously, we find the former much greater than the latter.

It is known that fatigue engenders poisoning, and that the blood of an animal in this abnormal state, injected into another animal, will produce all the phenomena of fatigue. When the leg of a frog that is being operated upon becomes fatigued, the poison may be, so to speak, neutralized, and the contractions may be made to continue by injecting salt water in the artery which carries the blood to the muscles. In case of a total absence of blood, its place may be wholly supplied by salt water. The frog may in this manner be kept alive one or two days and continue to react during the first few hours like a frog in normal condition.

These poisons, under the name of *ptomaines*, are now being studied. But until we obtain the knowledge which will enable us to neutralize them chemically, it is well to know that their elimination may be facilitated by all the various operations calculated to accelerate respiration, massage, etc.

Severe intellectual labor diminishes the pulse, produces a fullness in the head, causes palpitation of the heart, pain in the brain and in the muscles of the eye, sometimes photophobia and often vertigo. Dyspepsia, also, is among its painful consequences. Violent muscular exercise has been prescribed as a remedy for all these ills, but this is shown to be a mistake. The only remedy is rest—a complete cessation of mental labor, the disturbing cause. The fact is that, after a prolonged physical effort, nervous excitement increases in proportion as muscular energy diminishes, and this excitement is apt to extend to other muscles which should not be brought into participation.

Another device of M. Mosso, a modification of the ergograph, which he calls the *ponomètre*, permits him to measure this *travail à vide*, as he

designates the uncontrollable, fruitless, nervous activity superinduced by over-fatigue, and which is so exhaustive to the nervous centers. He shows, furthermore, by his experiments on carrier pigeons, that excessive muscular fatigue produces anæmia of the brain. A slight modification in cerebral circulation is sufficient to impair the intellectual faculties and may even determine a swoon. In experiments made upon a subject named Bertino, the author produced syncope and convulsions by a compression of the carotid arteries—an opening of some half inch in the frontal region of his subject, enabling him to register the pulsations of the brain meanwhile.

Every one has heard of *curare*, first introduced into Europe in 1595. It is a dark-brown, solid substance contained in little earthen pots, as prepared by the Indians of South America, by whom it is used principally to poison their arrowheads for war and the chase. The active principle in curare is its curarine, a ternary substance consisting of azote, hydrogen and carbon. This substance has two remarkable qualities: Contrary to what is usually the case with vegetable poisons, it may be absorbed internally with impunity, and in fairly large doses (by mammals, at least), whereas in the form of hypodermic injections it becomes a violent poison. On the other hand, it does not affect the nervous centers—the mental powers, the sensitive nerves and the muscles, while paralyzing the motor nerve. It doubtless especially affects the terminal plate where the motor nerve unites with the muscle. It kills by arresting the heart's action.

Professor Wedensky, of the St. Petersburg University, has lately reproduced the paralyzing effect of curare by a very different process. With the electric apparatus of Dubois Raymond he excites the motor nerve by frequent and violent currents. Under the influence of this irritating treatment, the muscle, instead of contracting, relaxes almost completely, and its condition becomes analogous to that produced by the mysterious influence of the curare. As the intensity and frequency of these excitations are diminished, the muscle tends to resume its contractile power and to return to its normal state.

These experiments are of the greatest interest. They show the fatal consequences attending frequent and intense nervous effort; they permit us at the same time to calculate the danger of paralysis and to anticipate it. These new processes enable us to distinguish the normal muscle from the enervated muscle—that is to say, the muscle deprived of the influence of the spinal marrow and the nervous fibres—after long and intense irritation, whether caused by over-taxation of the brain or of the muscles.

Professor Wedensky calls attention to the fact that the enervated muscle in presence of the electric battery acts in a much simpler manner than the normal muscle when the excitations traverse the tissues in their entire length. The normal muscle, subjected to currents of gradually increasing intensity, will contract but slightly at first, then more, and then less again; whereas, the enervated muscle will increase its contractions with the intensified current, relaxing as the intensity diminishes. Furthermore, if a second current be added to the first, it will have no effect on the normal muscle, while for the enervated muscle the second current reinforces the first.

A stethscopic auscultation of the muscles after frequent irritations will, in case of enervation, reveal sounds whose rhythm corresponds almost exactly with that of the induced current; the vibrations of the normal muscle, on the contrary, will be found to maintain their own independent rhythm.

Finally, it must be remarked that the normal muscle is much more excitable under the influence of an ascending current than a descending one. The contrary is the case for the enervated muscle, and even for the muscle that is simply fatigued.

From these facts results an important practical application, an exact method for the examination of cases of fatigue and paralysis. For instance, let the subject under examination clasp in his right hand the negative pole while the positive pole rests on his right foot; then ascertain the degree of intensity required to produce the least possible contraction of the muscles traversed by the current; whereupon reverse the order of the electrodes, placing the positive above and the negative below, thus subjecting

the same muscle to a descending current of the same character, the intensity of which, like the first, shall be the least perceptible. If the intensity of this latter current proves to be inferior to that of the former, the inference is that the muscular mass experimented upon is enervated. The greater the difference between the two degrees of intensity, the more serious will be the state of muscular enervation.

The great question for physiologists to answer now is: By what means are we to realize the full measure of muscular capacity in man and beast? The problem is in their hands, and the merit of MM. Mosso and Wedensky is that they have succeeded in studying experimentally some of the questions so deeply interesting to those engaged in this work.

CHARLES HENRY.

PARIS.

List of Mammals collected in the Black Hills Region of South Dakota and in Western Kansas by W. W. Granger, with field notes by the collector. By J. A. ALLEN. Bull. American Museum Nat. Hist., Vol. VII., pp. 259–274, Aug. 21, 1895.

The Black Hills region is one of more than ordinary interest to the naturalist, and it has received its full share of attention. Perhaps no area of equal size in the United States has been more closely studied by geologists and paleontologists, and it has been visited more than once by zoölogists and botanists.

The special interest attaching to the Black Hills, from the standpoint of the living fauna and flora, centers in the fact that it is the easternmost of the outlying boreal islands belonging in a general way to the Rocky Mountain region. This was clearly indicated by the first report on its mammals and birds, published by Geo. Bird Grinnell in 1875. Since then it has been visited three times by the experienced mammal collector, Mr. Vernon Bailey, but the results of his labors have not yet been published. The present paper by Dr. Allen, based on a collection made by Walter W. Granger in 1894, is therefore the first enumeration of the mammals of the region since modern methods of trapping came into vogue.

Three life zones—*Boreal*, *Transition* and *Upper Sonoran*—are embraced in the area covered by the report, though this important fact is not recognized by the author. The higher parts of the Black Hills are *Boreal;* the lower slopes, embracing most of the pine forest, are *Transition;* the adjacent 'bad lands' south of the Cheyenne River are *Upper Sonoran.* The Boreal element is completely isolated, being separated by a wide interval from the nearest land of sufficient elevation to support a similar fauna and flora. The following Boreal species occur in the Black Hills: *Microtus longicaudus*, *Evotomys g. brevicaudus*, *Peromyscus l. arcticus*, *Neotoma cinerea* [=*'grangeri'*]. *Sciurus h. dakotensis*, *Arctomys dakota*, *Sorex personatus* [recorded as *forsteri*], *Tamias 4-vit. borealis* and *Zapus.* The Transition element covers the greater part of the hills, and stretches uninterruptedly northward east of the Little Missouri River. It is inhabited by *Lepus campestris*, *Onychomys leucogaster*, *Neotoma rupicola*, *Peromyscus nebrascensis* and *Microtus austerus haydeni.* The Upper Sonoran element finds its northern limit near the Cheyenne River, on the east side of the Hills, but pushes farther north on the west side. It introduces several species (*Geomys lutescens*, *Perognathus paradoxus*, *Perodipus richardsoni*, *Corynorhinus 'townsendi'* and a few others) not occurriug elsewhere in the region.

Dr. Allen describes a new cottontail (*Lepus sylvaticus grangeri*) from the higher parts of the Black Hills, and in a previous paper named as new several other mammals collected by Mr. Granger. It is stated that the Gray Pocket Gopher (*Thomomys talpoides*) "is found not only in the prairie country at the base of the Black Hills, but in the small parks in the Black Hills, at an altitude of 5500 ft." Specimens collected in the higher parts of the Black Hills by Mr. Bailey are not the same as those from the surrounding low country.

In all, 53 species are enumerated, with more or less full annotations. The specific name of the Black-tail deer is carried back from *macrotis* Say (1823) to *hemionus* Rafinesque (1817).

The list as a whole is a welcome addition to our local knowledge of the mammals of a small but interesting area.

C. H. M.